**Table 3. End-Use Adjustments for the Residential and Commercial Sectors**

| Sector | Fuel | End-Use | Multiplier |
|---|---|---|---|
| Residential | Gas | Space heating | 1.0 |
| | | Water heating | 1.1 |
| | | Other | 0.6 |
| Residential | Electric | Space heating | 0.8 |
| | | Space cooling | 1.2 |
| | | Water heating | 1.0 |
| | | Appliances & other | 0.9 |
| Commercial | Gas | Space heating | 0.9 |
| | | Water heating | 1.4 |
| | | Cooking | 0.6 |
| | | Other | 0.6 |
| Commercial | Electricity | Space heating | 0.2 |
| | | Space cooling | 1 |
| | | Ventilation | 0.9 |
| | | Water heating | 0.6 |
| | | Lighting | 1.2 |
| | | Cooking | 0.5 |
| | | Refrigeration | 0.8 |
| | | Office equipment | 1.1 |
| | | Other | 0.5 |

*Savings in Year 1*

In the first year, the vast bulk of the behavioral savings can be achieved, plus one year of hardware savings. Across the different fuels and sectors, we estimate that approximately half of the five-year savings can be achieved in the first year, assuming a high prices and an active efficiency promotion campaign, with the remaining savings evenly distributed across the remain years of the study period.

*Estimates of Implementable Residential and Commercial Energy Savings*

Based on the above data, for each state, the base case end-use share for each state was multiplied by the appropriate end-use factor and overall achievable savings estimate to come up with maximum five-year savings. These savings were then multiplied by the numeric percentage for each state's current programs and policies, in order to reduce savings in those states with low or moderate current programs and policies. The result is total percent savings, by state, over five years. As noted above, the first year savings are half of the five-year savings figures. State-by-state savings estimates are provided in Table 4 and Table 5. A more detailed breakdown of the savings measures are presented in Appendix B.

**Table 4. Estimated Residential and Commercial Natural Gas Energy Efficiency and Conservation Savings**

| State | State Score | Commercial: Savings Possible In 5 Yrs | Commercial: Adjusted 5 Yr Savings | Commercial: Year-One Savings | Residential: Savings Possible In 5 Yrs | Residential: Adjusted 5 Yr Savings | Residential: Year-One Savings |
|---|---|---|---|---|---|---|---|
| Alabama | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Arizona | b | 4.7% | 4.0% | 2.0% | 5.3% | 4.5% | 2.2% |
| Arkansas | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| California | a | 4.8% | 4.8% | 2.4% | 5.1% | 5.1% | 2.6% |
| Colorado | b | 4.7% | 4.0% | 2.0% | 5.2% | 4.4% | 2.2% |
| Connecticut | a | 4.7% | 4.7% | 2.3% | 5.2% | 5.2% | 2.6% |
| Delaware | b | 4.5% | 3.8% | 1.9% | 5.2% | 4.4% | 2.2% |
| Florida | c | 4.5% | 3.1% | 1.6% | 4.8% | 3.4% | 1.7% |
| Georgia | d | 4.5% | 2.5% | 1.2% | 5.2% | 2.9% | 1.4% |
| Idaho | b | 4.7% | 4.0% | 2.0% | 5.2% | 4.4% | 2.2% |
| Illinois | b | 4.6% | 3.9% | 1.9% | 5.2% | 4.4% | 2.2% |
| Indiana | c | 4.6% | 3.2% | 1.6% | 5.2% | 3.6% | 1.8% |
| Iowa | b | 4.6% | 3.9% | 2.0% | 5.2% | 4.4% | 2.2% |
| Kansas | d | 4.6% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Kentucky | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Louisiana | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Maine | a | 4.7% | 4.7% | 2.3% | 5.2% | 5.2% | 2.6% |
| Maryland | b | 4.5% | 3.8% | 1.9% | 5.1% | 4.4% | 2.2% |
| Massachusetts | a | 4.7% | 4.7% | 2.3% | 5.2% | 5.2% | 2.6% |
| Michigan | b | 4.6% | 3.9% | 1.9% | 5.2% | 4.4% | 2.2% |
| Minnesota | b | 4.6% | 3.9% | 2.0% | 5.2% | 4.4% | 2.2% |
| Missouri | d | 4.6% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Mississippi | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Montana | c | 4.7% | 3.3% | 1.6% | 5.2% | 3.7% | 1.8% |
| Nebraska | d | 4.6% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Nevada | c | 4.7% | 3.3% | 1.6% | 5.3% | 3.7% | 1.8% |
| New Hampshire | b | 4.7% | 4.0% | 2.0% | 5.2% | 4.4% | 2.2% |
| New Jersey | a | 4.5% | 4.5% | 2.2% | 5.1% | 5.1% | 2.6% |
| New Mexico | d | 4.7% | 2.6% | 1.3% | 5.3% | 2.9% | 1.5% |
| New York | a | 4.5% | 4.5% | 2.2% | 5.1% | 5.1% | 2.6% |
| North Carolina | d | 4.5% | 2.5% | 1.2% | 5.2% | 2.9% | 1.4% |
| North Dakota | d | 4.6% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Ohio | c | 4.6% | 3.2% | 1.6% | 5.2% | 3.6% | 1.8% |
| Oklahoma | d | 4.7% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Oregon | a | 4.8% | 4.8% | 2.4% | 5.1% | 5.1% | 2.5% |
| Pennsylvania | a | 4.5% | 4.5% | 2.2% | 5.1% | 5.1% | 2.6% |
| Rhode Island | a | 4.7% | 4.7% | 2.3% | 5.2% | 5.2% | 2.6% |
| South Carolina | d | 4.5% | 2.5% | 1.2% | 5.2% | 2.9% | 1.4% |
| South Dakota | d | 4.6% | 2.6% | 1.3% | 5.2% | 2.9% | 1.4% |
| Tennessee | c | 4.7% | 3.3% | 1.7% | 5.2% | 3.6% | 1.8% |
| Texas | a | 4.7% | 4.7% | 2.4% | 5.1% | 5.1% | 2.6% |
| Utah | b | 4.7% | 4.0% | 2.0% | 5.2% | 4.4% | 2.2% |
| Vermont | a | 4.7% | 4.7% | 2.3% | 5.2% | 5.2% | 2.6% |

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| | | Commercial | | | Residential | | |
|---|---|---|---|---|---|---|---|
| State | State Score | Savings Possible in 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings | Savings Possible in 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings |
| Virginia | c | 4.5% | 3.1% | 1.6% | 5.2% | 3.6% | 1.8% |
| Washington | b | 4.8% | 4.1% | 2.1% | 5.1% | 4.3% | 2.2% |
| West Virginia | d | 4.5% | 2.5% | 1.2% | 5.2% | 2.9% | 1.4% |
| Wisconsin | a | 4.6% | 4.6% | 2.3% | 5.2% | 5.2% | 2.6% |
| Wyoming | c | 4.7% | 3.3% | 1.6% | 5.2% | 3.7% | 1.8% |

**Table 5. Estimated Residential and Commercial Electric Energy Efficiency and Conservation Savings**

| | | Commercial | | | Residential | | |
|---|---|---|---|---|---|---|---|
| State | State Score | Savings Possible in 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings | Savings Possible in 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings |
| Alabama | d | 6.5% | 3.6% | 1.8% | 5.7% | 3.2% | 1.6% |
| Arizona | b | 6.8% | 4.7% | 2.4% | 5.9% | 4.1% | 2.1% |
| Arkansas | d | 6.7% | 3.7% | 1.9% | 5.8% | 3.2% | 1.6% |
| California | a | 6.7% | 6.7% | 3.4% | 5.7% | 5.7% | 2.8% |
| Colorado | b | 6.8% | 4.7% | 2.4% | 5.6% | 3.9% | 2.0% |
| Connecticut | a | 6.8% | 6.8% | 3.4% | 5.6% | 5.6% | 2.8% |
| Delaware | b | 6.7% | 4.7% | 2.3% | 5.6% | 3.9% | 2.0% |
| Florida | c | 6.7% | 4.7% | 2.3% | 6.1% | 4.3% | 2.1% |
| Georgia | d | 6.7% | 4.7% | 2.3% | 5.8% | 4.1% | 2.0% |
| Idaho | b | 6.8% | 5.8% | 2.9% | 5.6% | 4.8% | 2.4% |
| Illinois | b | 6.7% | 5.7% | 2.8% | 5.7% | 4.8% | 2.4% |
| Indiana | c | 6.7% | 5.7% | 2.8% | 5.7% | 4.8% | 2.4% |
| Iowa | b | 6.8% | 5.8% | 2.9% | 5.7% | 4.8% | 2.4% |
| Kansas | d | 6.8% | 3.8% | 1.9% | 5.7% | 3.1% | 1.6% |
| Kentucky | d | 6.5% | 3.6% | 1.8% | 5.7% | 3.2% | 1.6% |
| Louisiana | d | 6.7% | 3.7% | 1.9% | 5.8% | 3.2% | 1.6% |
| Maine | a | 6.8% | 6.8% | 3.4% | 5.6% | 5.6% | 2.8% |
| Maryland | b | 6.7% | 5.7% | 2.8% | 5.8% | 4.9% | 2.5% |
| Massachusetts | a | 6.8% | 6.8% | 3.4% | 5.6% | 5.6% | 2.8% |
| Michigan | b | 6.7% | 4.7% | 2.3% | 5.7% | 4.0% | 2.0% |
| Minnesota | b | 6.8% | 5.8% | 2.9% | 5.7% | 4.8% | 2.4% |
| Missouri | d | 6.8% | 3.8% | 1.9% | 5.7% | 3.1% | 1.6% |
| Mississippi | d | 6.5% | 3.6% | 1.8% | 5.7% | 3.2% | 1.6% |
| Montana | c | 6.8% | 4.7% | 2.4% | 5.6% | 3.9% | 2.0% |
| Nebraska | d | 6.8% | 3.8% | 1.9% | 5.7% | 3.1% | 1.6% |
| Nevada | c | 6.8% | 4.7% | 2.4% | 5.9% | 4.1% | 2.1% |
| New Hampshire | b | 6.8% | 5.8% | 2.9% | 5.6% | 4.8% | 2.4% |
| New Jersey | a | 6.6% | 6.6% | 3.3% | 5.6% | 5.6% | 2.8% |
| New Mexico | d | 6.8% | 3.7% | 1.9% | 5.9% | 3.3% | 1.6% |
| New York | a | 6.6% | 6.6% | 3.3% | 5.6% | 5.6% | 2.8% |
| North Carolina | d | 6.7% | 3.7% | 1.8% | 5.8% | 3.2% | 1.6% |

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| | | Commercial | | | Residential | | |
|---|---|---|---|---|---|---|---|
| State | State Score | Savings Possible In 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings | Savings Possible In 5 Yrs | Adjusted 5 Yr Savings | Year-One Savings |
| North Dakota | d | 6.8% | 3.8% | 1.9% | 5.7% | 3.1% | 1.6% |
| Ohio | c | 6.7% | 4.7% | 2.3% | 5.7% | 4.0% | 2.0% |
| Oklahoma | d | 6.7% | 3.7% | 1.9% | 5.8% | 3.2% | 1.6% |
| Oregon | a | 6.7% | 6.7% | 3.4% | 5.5% | 5.5% | 2.8% |
| Pennsylvania | a | 6.6% | 4.6% | 2.3% | 5.6% | 3.9% | 2.0% |
| Rhode Island | a | 6.8% | 6.8% | 3.4% | 5.6% | 5.6% | 2.8% |
| South Carolina | d | 6.7% | 3.7% | 1.8% | 5.8% | 3.2% | 1.6% |
| South Dakota | d | 6.8% | 3.8% | 1.9% | 5.7% | 3.1% | 1.6% |
| Tennessee | c | 6.5% | 4.6% | 2.3% | 5.7% | 4.0% | 2.0% |
| Texas | a | 6.7% | 6.7% | 3.4% | 5.9% | 5.9% | 3.0% |
| Utah | b | 6.8% | 5.8% | 2.9% | 5.6% | 4.8% | 2.4% |
| Vermont | a | 6.8% | 6.8% | 3.4% | 5.6% | 5.6% | 2.8% |
| Virginia | c | 6.7% | 4.7% | 2.3% | 5.8% | 4.1% | 2.0% |
| Washington | b | 6.7% | 5.7% | 2.9% | 5.5% | 4.7% | 2.3% |
| West Virginia | d | 6.7% | 3.7% | 1.8% | 5.8% | 3.2% | 1.6% |
| Wisconsin | a | 6.7% | 6.7% | 3.3% | 5.7% | 5.7% | 2.8% |
| Wyoming | c | 6.8% | 4.7% | 2.4% | 5.6% | 3.9% | 2.0% |

### *Industrial Methodology and Characterization*

*General Approach*

A "bottom-up" approach was used for determining the electricity and natural gas savings potential for the industrial sector. The estimated savings were calculated based on electric and natural gas end-use savings estimates. Because there is no specific state-level end-use data for the industrial sector, the state estimates were based on the four Census regions for which specific sub-sector and end-use data is available through the Energy Information Administration. Once maximum achievable savings estimates were determined, a weighting factor based on each state's existing programmatic infrastructure was applied.

*Energy Savings by End-Use*

Disaggregated state-level energy use is not available. In order to develop estimates for each of the 48 states, regional data from the Manufacturing Energy Consumption Survey (MECS) 1998 was used (EIA 2001b). Regional savings estimates were determined using the methodology described below.

MECS provides energy consumption and end-use data on a sub-sector level for four major Census regions—Northeast, Midwest, South, and West. Because the industrial sector is highly heterogeneous, it is necessary to obtain data on a 3-digit North American Industrial Classification System (NAICS) code level in order to determine accurate estimates of potential savings in a region. It was assumed that the breakdown of energy use in each state was identical to its Census region breakdown. The six industrial sub-sectors that were included in estimating the Census region electricity and natural gas savings are summarized in Table 6.

**Table 6. North American Industrial Classification System (NAICS) Key**

| NAICS Code | Industrial Sub-Sector |
|---|---|
| 311 | Food |
| 322 | Paper |
| 324 | Petroleum and Coal Products |
| 325 | Chemicals |
| 327 | Nonmetallic Mineral Products |
| 331 | Primary Metals |
| | All Others |

These sub-sectors align with the sub-sectors represented in the EEA natural gas forecasting model. Specific end-use data for each of these sub-sectors within each of the four census regions was obtained. For determining electricity conservation potential, the following end-uses were considered: motors, process heating, HVAC, and lighting. For determining the natural gas conservation potential, the following end-uses were considered: boilers, process heating, and space heating.

The conservation potential by end-use was based on figures reported in "California Industrial Energy Efficiency Market Characterization Study" (XENERGY 2001). This study was done for the Pacific Gas and Electric Company (PG&E), and the end-use savings figures line up closely with recent studies done by ACEEE and Optimal Energy Inc. (NYSERDA 2003). The XENERGY study details achievable savings by end-use for both electric and natural gas-fired processes. Because the scope of our study focused on a relatively short 1-year and 5-year timeframe, we estimated that 50% of the total achievable savings cited in the study would be achievable by year 5. The Energy study concentrated on a 10-yr timeframe, making the 50% assumption for the 5-year outlook reasonable. These estimates align closely with data obtained from the Industrial Assessment Centers (IAC) database (IAC 2003). Table 7 includes maximum achievable 5-year savings estimates by end-use.

**Table 7. Industrial Sector End-Use Breakdown**

| | End-Uses | 5-Year Savings Potential |
|---|---|---|
| Electricity End-Uses | Motors | 7% |
| | Process Heating | 5% |
| | HVAC | 12% |
| | Lighting | 10% |
| Natural Gas End-Uses | Boilers | 6% |
| | Process Heating | 5% |
| | Space Heating | 5% |

These end-use savings estimates were then applied to the unique end-use breakdowns for the seven major industrial sub-sectors that were considered in the analysis. Since each Census region has a distinct mix of industrial activity, the total regional savings potential will vary from the national average. Table 8 includes the end-use breakdowns for the various industrial sub-groups in the analysis.

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**Table 8. Industrial Sub-Sector End-Use**

| NAICS Code | Industrial Sub-Sector | Electricity End-Uses (Percent of Sub-Sector Electricity Consumption) | | | | Natural Gas End-Uses (Percent of Sub-Sector Natural Gas Consumption) | | |
|---|---|---|---|---|---|---|---|---|
| | | Motors | Process Heating | HVAC | Lighting | Boilers | Process Heating | Space Heating |
| 311 | Food | 78% | 3% | 6% | 9% | 60% | 32% | 6% |
| 322 | Paper | 89% | 2% | 3% | 4% | 70% | 21% | 3% |
| 324 | Petroleum and Coal Products | 92% | 0% | 0% | 8% | 26% | 66% | 2% |
| 325 | Chemicals | 70% | 3% | 6% | 4% | 50% | 44% | 2% |
| 327 | Nonmetallic Mineral Products | 61% | 16% | 5% | 4% | 4% | 88% | 5% |
| 331 | Primary Metals | 26% | 22% | 3% | 3% | 15% | 77% | 7% |
| | All Others | 64% | 12% | 9% | 7% | 38% | 51% | 7% |

*Overall Energy Savings Achievable Over Five Years*

A variety of studies have been conducted in recent years to estimate the economic and achievable efficiency potentials for reducing gas and electricity use in different states. Economic potential is an estimate of the savings that can be achieved if all measures, which are cost-effective to end-users, are implemented. Achievable potential is a subset of economic potential and includes allowances for reasonable measure penetration rates given likely policy and program interventions. Following the previous methodology, the following maximum achievable five-year savings potentials for the various census regions of the industrial sector are displayed in Table 9.

**Table 9. Achievable Potential for the Industrial Sector in 2008**

| Census Region | Electricity Savings Potential | Natural Gas Savings Potential |
|---|---|---|
| Northeast | 5.96% | 4.53% |
| Midwest | 6.04% | 4.94% |
| South | 6.16% | 5.19% |
| West | 5.41% | 5.19% |

*Savings in Year 1*

In the first year under an aggressive policy scenario, a large portion (40%) of the five-year savings can be achieved. This result depends on an assumption of relatively high prices and an active efficiency promotion campaign.

*Estimates of Implementable State Industrial Energy Savings*

Based on the above data, the following one- and five-year cumulative state-by-state results were obtained (see Table 10):

**Table 10. State Industrial Savings in 2004 and 2008**

| State | Infra-structure Score | Electricity Savings | | Natural Gas Savings | |
|---|---|---|---|---|---|
| | | 1 year | 5 years | 1 year | 5 years |
| Alabama | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Arizona | c | 1.51% | 3.79% | 1.45% | 3.63% |
| Arkansas | d | 1.35% | 3.39% | 1.14% | 2.85% |
| California | a | 2.16% | 5.41% | 2.08% | 5.19% |
| Colorado | c | 1.51% | 3.79% | 1.45% | 3.63% |
| Connecticut | a | 2.38% | 5.96% | 1.81% | 4.53% |
| Delaware | c | 1.72% | 4.31% | 1.45% | 3.63% |
| Florida | c | 1.72% | 4.31% | 1.45% | 3.63% |
| Georgia | c | 1.72% | 4.31% | 1.45% | 3.63% |
| Idaho | b | 1.84% | 4.60% | 1.76% | 4.41% |
| Illinois | b | 2.05% | 5.14% | 1.68% | 4.20% |
| Indiana | b | 2.05% | 5.14% | 1.68% | 4.20% |
| Iowa | b | 2.05% | 5.14% | 1.68% | 4.20% |
| Kansas | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Kentucky | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Louisiana | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Maine | a | 2.38% | 5.96% | 1.81% | 4.53% |
| Maryland | b | 2.09% | 5.23% | 1.76% | 4.41% |
| Massachusetts | a | 2.38% | 5.96% | 1.81% | 4.53% |
| Michigan | c | 1.69% | 4.23% | 1.38% | 3.46% |
| Minnesota | b | 2.05% | 5.14% | 1.68% | 4.20% |
| Missouri | d | 1.33% | 3.32% | 1.09% | 2.72% |
| Mississippi | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Montana | c | 1.51% | 3.79% | 1.45% | 3.63% |
| Nebraska | d | 1.33% | 3.32% | 1.09% | 2.72% |
| Nevada | c | 1.51% | 3.79% | 1.45% | 3.63% |
| New Hampshire | b | 2.03% | 5.06% | 1.54% | 3.85% |
| New Jersey | a | 2.38% | 5.96% | 1.81% | 4.53% |
| New Mexico | d | 1.19% | 2.98% | 1.14% | 2.85% |
| New York | a | 2.38% | 5.96% | 1.81% | 4.53% |
| North Carolina | d | 1.35% | 3.39% | 1.14% | 2.85% |
| North Dakota | d | 1.33% | 3.32% | 1.09% | 2.72% |
| Ohio | c | 1.69% | 4.23% | 1.38% | 3.46% |
| Oklahoma | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Oregon | a | 2.16% | 5.41% | 2.08% | 5.19% |
| Pennsylvania | c | 1.67% | 4.17% | 1.27% | 3.17% |
| Rhode Island | a | 2.38% | 5.96% | 1.81% | 4.53% |
| South Carolina | d | 1.35% | 3.39% | 1.14% | 2.85% |
| South Dakota | d | 1.33% | 3.32% | 1.09% | 2.72% |
| Tennessee | c | 1.72% | 4.31% | 1.45% | 3.63% |
| Texas | a | 2.46% | 6.16% | 2.08% | 5.19% |
| Utah | b | 1.84% | 4.60% | 1.76% | 4.41% |
| Vermont | a | 2.38% | 5.96% | 1.81% | 4.53% |
| Virginia | c | 1.72% | 4.31% | 1.45% | 3.63% |
| Washington | b | 1.84% | 4.60% | 1.76% | 4.41% |
| West Virginia | d | 1.35% | 3.39% | 1.14% | 2.85% |
| Wisconsin | a | 2.42% | 6.04% | 1.98% | 4.94% |
| Wyoming | c | 1.51% | 3.79% | 1.45% | 3.63% |

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***Renewable Methodology and Characterization***

*General Approach*

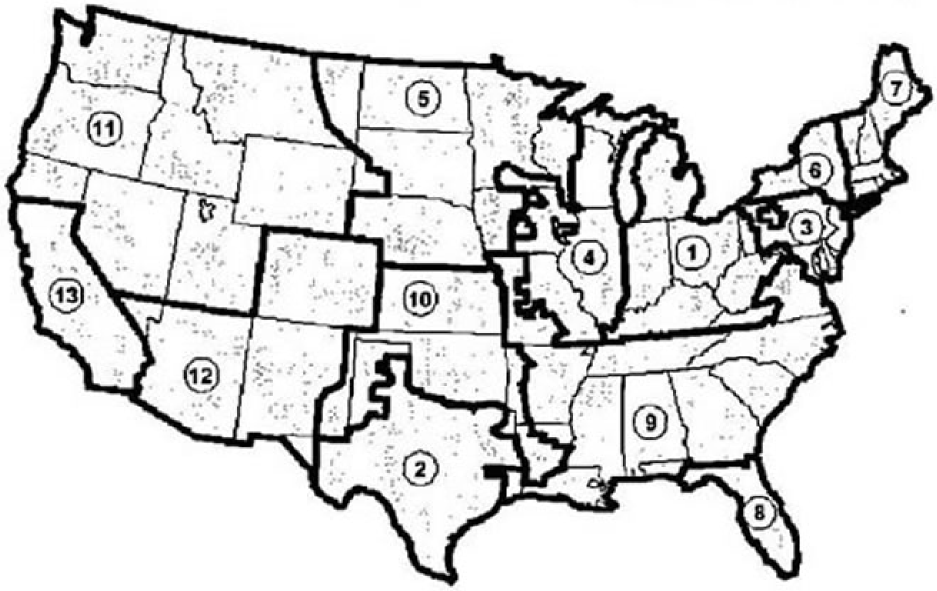
While estimates of the implementable potential for energy efficiency and conservation are somewhat available in the literature at a state level, data of nearer-term, implementable potential of renewable generation is less available. In addition, there is less need to make state-level estimates of renewables because generation markets are inherently multi-state. We elected to use the electric supply regions, used by EIA, which for the most part correspond to the National Electric Reliability Councils (NERC) sub-regions (Figure 8). The EEA model uses similar regions with the exception of Nevada which is placed in the same region as California, rather than with the upper West as does EIA and NERC.

We reviewed the available literature on renewables and interviewed experts. Based on the collected information, we developed estimates of the net additions of non-conventional hydro renewables for each of the thirteen EIA Electricity Supply Regions. These estimates were mapped to the EEA regions, and used as the model input. No independent assessment was attempted because of time and budget constraints. Nor was any attempt to estimate specific shares of renewable technologies, though it is likely that the renewables will be dominated by wind, along with biomass and solar in some regions.

*Sources for Estimates*

We reviewed the available literature on renewables and interviewed a number of leading experts. Many studies have looked at resource and economic potential at the state level and regional level, and most project the level that could be achieved over a fairly long policy horizon. Most of the studies use different assumptions, and study periods, so that it is difficult to place the findings on a common basis. One difficulty was that studies do not use a common definition of renewables. Most national data includes municipal solid waste (MSW) and conventional hydro power in the renewables definitions. Many renewable portfolio standards (RPS) exclude these two resources.

**Figure 8. National Energy Modeling System Electricity Supply Regions (EIA 2002)**




1 East Central Area Reliability Coordination Agreement
2 Electric Reliability Council of Texas
3 Mid-Atlantic Area Council
4 Mid-America Interconnected Network
5 Mid-Continent Area Power Pool
6 New York
7 New England
8 Florida Reliability Coordinating Council
9 Southeastern Electric Reliability Council
10 Southwest Power Pool
11 Northwest Power Pool
12 Rocky Mountain, Arizona, New Mexico, Southern Nevada
13 California

At the national level, EIA recently conducted two studies (EIA 2002, 2003) of the impacts of various RPSs using the National Energy Modeling System (NEMS). Both studies were prompted by requests from Congress to review legislation under consideration and look at 10 and 20% national RPS targets in 10 years. The base case developed for the more recent study was chosen as the base case for this study. However, data obtained for New York State indicated that the base case understated the anticipated renewables share (NYSERDA 2002b), so the base was modified from the EIA case.

A review of EIA's most recent regional projections from a national RPS indicated that they were not particularly aggressive. This result stems in large part from the fact that the modeled RPS only began in 2007, so little impact was realized. As a result, we decided we would turn to other sources for estimating near-term, implementable results.

The Environmental Law & Policy Center (ELCP 2001) had commissioned a study, *Repowering the Midwest* that presents energy futures in the Midwest, including a 2010 projection for renewables in the region. The prorated projection was for a renewables share of 1.4% in 2008. This was slightly higher than the EIA projection of 1.3%.

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Another study, *Powering the South*, was prepared by the Renewable Energy Policy Project (REPP 2001) for the South projecting a 4% market share in 2010. The prorated 2008 estimate is 3.2%, which contrasts with the EIA projection of 1.6%.

A similar study of the West is underway for Western Resource Advocates (WRA) (Nielsen 2003). Preliminary results for the three electricity supply regions are presented in Table 11. In addition, a UCS study for California projected a renewables share of 20% in 2010 that prorates to 17.1% in 2008 (UCS 2001). For Washington State, a recent study (Shimshak 2003) projected a 14% market share for 2020, which prorates to 4.1% in 2008. We chose to use the preliminary WRA estimates.

**Table 11. Projected Non-Hydro Renewables Share of Generation in the West (Nielsen 2003)**

| Region | 2008 Renewables Generation (Mill. MWh) | 2008 Renewables Share |
|---|---|---|
| ID, MT, OR, UT, WA, WY | 11.4 | 5.2% |
| AZ, CO, NM, NV | 8.5 | 7.3% |
| CA | 42.2 | 17.4% |

For New York State, three sources were used. NYSERDA has just released a study of energy efficiency and renewable energy potential (NYSERDA 2003). This study projects an economically achievable renewables share of 5.5% in 2008. A recent internal NYSERDA (Pakenas 2003) assessment projects renewables share of 5.9% in 2008 while environmental groups have been setting an RPS target of 27 million MWh (Greene 2003) that would prorate to an 8.7% market share in 2008. We chose to use the environmental groups' target.

Texas represents perhaps the most successful renewables market, with current installation of renewables (largely wind) outstripping the targets in the state's current RPS (about 2% of electric sales. While no systematic analysis has been done recently, renewables experts in the state believe Texas could achieve more than twice its existing 2008 target (Marston 2003).

*Estimates of Implementable Renewable Energy Resources*

Based on this review of existing studies, we developed a set of estimates for additional non-hydro generation that could be plausibly installed in each region by 2008 for each of the thirteen EIA Electricity Supply Regions. These estimates were mapped to the EEA regions. In most cases this represented an approximate doubling of installed generation relative to the EIA renewables base case discussed above. These results and the adjusted EIA base case are presented in Table 12.

We assume that the new renewable generation will displace existing and new conventional generation in the region. The electric module of the EEA model handles the dispatch of the additional renewables. We assume that since natural gas is the fuel on the margin in most of these regions, renewable generation is likely to disproportionately displace natural gas generation.

**Table 12. Base Case and Policy Case Renewables Generation (Mill. MWh) by EIA Electricity Supply Regions**

| | | EIA Renewables Base Case (2003) | | | | | 2008 Policy Case | | |
|---|---|---|---|---|---|---|---|---|---|
| EIA Region | States in Region | 2008 Total Electricity Generation | 2008 Base Renew. Generation | Conventional Hydro Generation | Non-Hydro Renew. Generation | Renew. Share | Total Non-Hydro Renewables Generation | Net New Renewables Generation | Renew. Share |
| 1 | MI, IN, OH, WV | 680.79 | 7.86 | 3.18 | 4.69 | 0.7% | 9.37 | 4.69 | 1.4% |
| 2 | TX | 318.58 | 9.65 | 0.73 | 8.92 | 2.8% | 15.32 | 6.40 | 4.8% |
| 3 | DE, DC, MD, NJ, PA | 291.47 | 12.26 | 4.52 | 7.74 | 2.7% | 15.48 | 7.74 | 5.3% |
| 4 | WI, IL | 310.40 | 6.00 | 2.45 | 3.55 | 1.1% | 20.23 | 16.67 | 6.5% |
| 5 | IA, MN, MO, NE, ND, SD | 198.48 | 19.80 | 15.04 | 4.76 | 2.4% | 24.33 | 19.58 | 12.3% |
| 6 | NY | 172.40 | 23.46 | 26.40 | 10.20 | 5.9% | 15.00 | 4.80 | 8.7% |
| 7 | CT, MA, ME, NH, RI, VT | 131.16 | 12.99 | 5.10 | 7.88 | 6.0% | 15.76 | 7.88 | 12.0% |
| 8 | FL | 182.76 | 4.49 | 0.05 | 4.45 | 2.4% | 11.72 | 7.27 | 6.4% |
| 9 | AL, GA, KY, NC, SC, TN, VA | 910.18 | 39.15 | 33.28 | 5.87 | 0.6% | 23.26 | 17.38 | 2.6% |
| 10 | AR, KS, LA, MS, OK | 203.69 | 5.82 | 5.10 | 0.72 | 0.4% | 1.45 | 0.72 | 0.7% |
| 11 | OR, WA, ID, MT, NV, UT, WY | 311.19 | 165.36 | 154.31 | 11.06 | 3.6% | 21.16 | 10.10 | 6.8% |
| 12 | AZ, CO, NM | 209.80 | 20.81 | 15.12 | 5.69 | 2.7% | 10.91 | 5.22 | 5.2% |
| 13 | CA | 256.76 | 63.63 | 41.20 | 22.43 | 8.7% | 44.01 | 21.57 | 17.1% |

## Changes in Natural Gas Consumption, Price, and Expenditures

### *Efficiency and Renewables Reduce Gas Consumption*

Four different scenarios were examined in detail as part of this analysis. First, a "national" scenario was examined in which all 48 states in the continental United States implemented energy efficiency and renewable energy. In the other three scenarios, we looked at the effects of implementing efficiency or renewable energy in just one region or state. Table 13 displays the change in natural gas consumption on a national level for each of the scenarios. Our initial discussion will focus on the national scenario, followed by discussion of the other scenarios as part of a discussion of selected regional effects.

Our analysis of the national scenario shows that energy efficiency could reduce natural gas consumption by 1.1% in the next 12 months, significantly reducing wholesale and retail prices. By 2008, the combined energy efficiency and renewable energy measures would reduce total gas consumption by 5.5% (see Table 13). The power generation sector would

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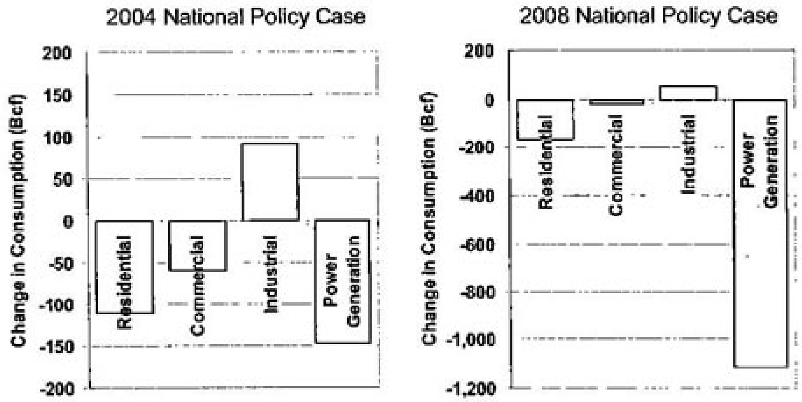
represent the largest national natural gas savings in both 2004 and 2008 (see Figure 9). The 2004 results reflect the impact of electric efficiency savings by all consumers while the 2008 results reflect the combined effects of efficiency and expanded use of renewables that would both displace gas-fired electricity generation. Detailed sectorial and state specific information about natural gas consumption is presented in Appendix C.

**Figure 9. Natural Gas Savings from Energy Efficiency and Renewable Energy**




Residential consumers could make important contributions to natural gas efficiency (especially in the near-term) through many low- and no-cost measures such as furnace tune-ups and shifts to more efficient. These savings are projected to grow over the five years studied.

In addition, electricity savings, particularly from residential air conditioners are important in reducing demand for natural gas-produced electricity. Commercial air conditioning and lighting improvements are also important to electric savings.
Commercial gas savings are more modest than from the other sectors.

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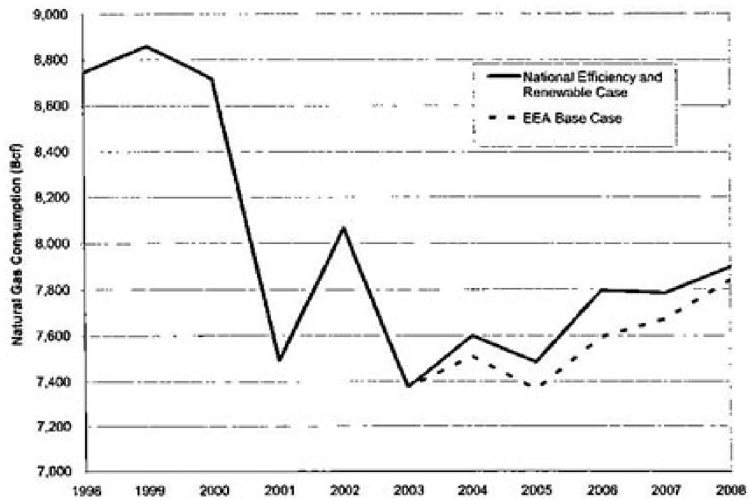
**Table 13. Changes in Natural Gas Consumption under Different Policy Scenarios**

| | Change from EEA Base Case in 2004 | | Change From EEA Base Case in 2008 | |
|---|---|---|---|---|
| | Bcf | Percent | Bcf | Percent |
| **Total Demand** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -238 | -1.1% | -1,349 | -5.5% |
| ACEEE: Pacific West | -31 | -0.1% | -290 | -1.2% |
| ACEEE: Northeast/PJM | -31 | -0.1% | -230 | -0.9% |
| ACEEE: NY Renewables | 0 | 0.0% | -9 | 0.0% |
| **Residential** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -112 | -2.1% | -167 | -3.1% |
| ACEEE: Pacific West | -14 | -0.3% | -12 | -0.2% |
| ACEEE: Northeast/PJM | -30 | -0.6% | -48 | -0.9% |
| ACEEE: NY Renewables | 0 | 0.0% | 1 | 0.0% |
| **Commercial** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -59 | -1.8% | -22 | -0.6% |
| ACEEE: Pacific West | -5 | -0.2% | 16 | 0.5% |
| ACEEE: Northeast/PJM | -19 | -0.6% | -18 | -0.5% |
| ACEEE: NY Renewables | 0 | 0.0% | 1 | 0.0% |
| **Industrial** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | 91 | 1.2% | 57 | 0.7% |
| ACEEE: Pacific West | 41 | 0.5% | 60 | 0.8% |
| ACEEE: Northeast/PJM | 53 | 0.7% | 72 | 0.9% |
| ACEEE: NY Renewables | 0 | 0.0% | 9 | 0.1% |
| **Power Generation** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -147 | -3.3% | -1,115 | -18.5% |
| ACEEE: Pacific West | -51 | -1.1% | -332 | -5.5% |
| ACEEE: Northeast/PJM | -26 | -0.6% | -199 | -3.3% |
| ACEEE: NY Renewables | 0 | 0.0% | -19 | -0.3% |

Note: The sum of end-use sector consumption will not equal the national total because pipeline fuel, and lease and plant fuel are not reported in the table.

Industrial gas consumption would decline less under all the efficiency and renewable energy scenarios than in the base case—in large part as a result of a decrease in "demand destruction" in the base case (see Figure 10). "Demand destruction" refers to plant closures and layoffs at natural gas-dependent industries such as chemicals and primary metals that would have occurred as a result of higher natural gas prices. Because gas prices would be lower as a result of energy efficiency and renewable energy investments, gas would be more affordable for feedstock uses and certain more such businesses would remain in operation relative to the base case. Hence industrial demand for natural gas would increase slightly under the scenarios run in this study. The industrial increases in gas use would be greatest in the first three years of the analysis when the projected natural gas consumption declines from the base case are most pronounced.

**Figure 10. Efficiency and Renewable Energy Frees Gas for Industrial Use**




The reductions in natural gas consumption the power sector are slightly lower that the combined reductions in the residential and commercial sector in 2004 when only electric efficiency measures are implemented. By 2008, with four years of increased renewables and five years of electric efficiency measures in place, the power generation sector dominates the gas savings. These results reflect the importance of the growing relationship between natural gas markets and the electric power sector.

***Reductions in Natural Gas Consumption Reduce Natural Gas Prices***

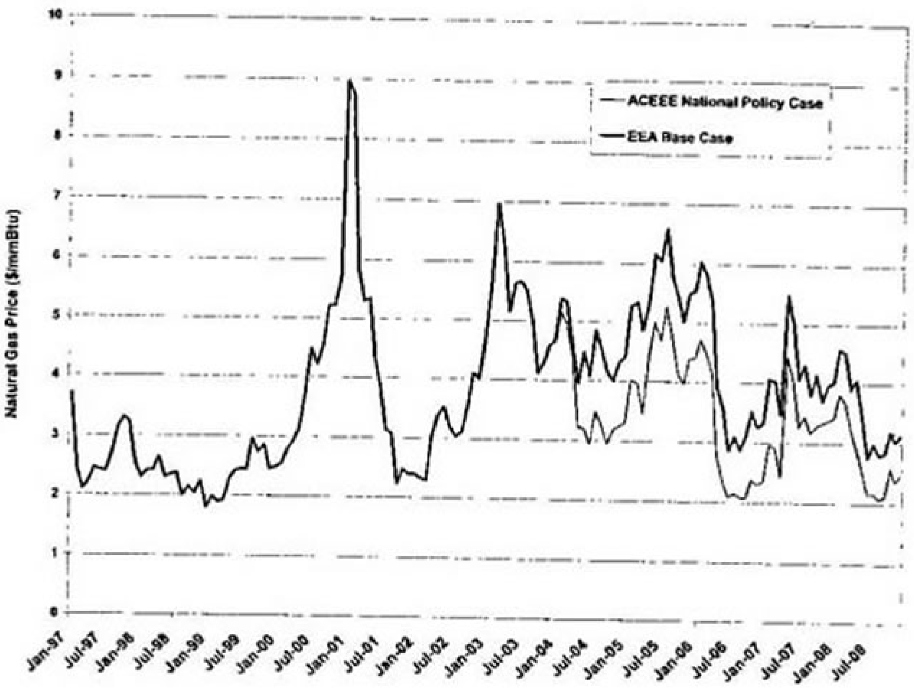
As we have seen in recent years, modest increases in natural gas consumption have produced dramatic increases in natural gas prices. This volatility results from a very tight supply situation. As we would expect from this experience, the modeling shows that modest reductions in natural gas consumption from energy efficiency and renewable energy generation would result in large reduction in the price of natural gas. The national reference Henry Hub wholesale price (see map in Appendix A) would be reduced by almost $0.90/MMBtu or 20% in 2004, and by 22% in 2008 (see Figure 11 and Table 14).

*Regional Gas Savings Would Have National Price Impacts*

Energy efficiency and renewable energy efforts that would be restricted to a region would reduce wholesale and retail prices in the region in which they would be implemented. The Northeast/PJM scenario would have about the same impact on the New York City Hub as it would on New England hub prices of natural gas (see map in Appendix A and Table 14). Under this scenario, the average New York State residential gas customer could save about $60 annually on her gas bill. Likewise, the Pacific West scenario would have marked price impact on the Southern California Hub wholesale price. At the retail level, the average

California residential natural gas customer would save about $37/year, and the combined state residential, commercial, and industrial savings would average over $900 million annually for the five years studied.

**Figure 11. Energy Efficiency and Renewable Energy Reduce Wholesale Gas Prices**




In addition, the modeling indicates that these regional efforts would cause natural gas price reductions nationally—for example, the Northeast/PJM scenario would produce a 6.1% reduction in Southern California Hub pricing in 2004 and the Pacific West Scenario would produce a 5.2% reduction in the New York City hub wholesale price of gas (see map in Appendix A and Table 14). It is important to remember, as will be discussed in greater detail in the next section, that changes in natural gas prices account for only a fraction of the consumer bill savings that result from expanded deployment of energy efficiency and renewable energy resources. The bill savings that result from reductions in both gas and electricity consumption are important contributors to consumers' overall benefits. Thus, while consumers everywhere will benefit from nationally reduced natural gas prices, only consumers in those regions in which greater energy efficiency and renewables are implemented will realize this large fraction of the savings potential.

**Table 14. Change in Wholesale Natural Gas Prices at Key Transmission Hubs***

| Gas Prices (in 2002$/MMBtu) | Change from EEA Base Case in 2004 | | Change from EEA Base Case in 2008 | |
|---|---|---|---|---|
| | Dollars | Percent | Dollars | Percent |
| **Henry Hub** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -0.89 | -19.8% | -0.76 | -22.1% |
| ACEEE: Pacific West | -0.27 | -5.9% | -0.15 | -4.3% |
| ACEEE: Northeast/PJM | -0.28 | -6.2% | -0.21 | -6.0% |
| ACEEE: NY Renewables | 0.00 | 0.0% | -0.02 | -0.5% |
| **New York City** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -0.95 | -19.0% | -0.94 | -23.6% |
| ACEEE: Pacific West | -0.26 | -5.2% | -0.13 | -3.2% |
| ACEEE: Northeast/PJM | -0.35 | -7.1% | -0.43 | -10.9% |
| ACEEE: NY Renewables | 0.00 | 0.0% | -0.07 | -1.8% |
| **New England** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -0.95 | -19.2% | -0.90 | -23.6% |
| ACEEE: Pacific West | -0.26 | -5.3% | -0.14 | -3.6% |
| ACEEE: Northeast/PJM | -0.35 | -7.0% | -0.36 | -9.3% |
| ACEEE: NY Renewables | 0.00 | 0.0% | -0.03 | -0.7% |
| **Southern California** | | | | |
| EEA July 2003 Base Case | | | | |
| ACEEE: National | -0.91 | -20.1% | -0.95 | -29.1% |
| ACEEE: Pacific West | -0.34 | -7.4% | -0.66 | -20.3% |
| ACEEE: Northeast/PJM | -0.28 | -6.1% | -0.15 | -4.7% |
| ACEEE: NY Renewables | 0.00 | 0.0% | -0.01 | -0.4% |

* See Appendix A for a map of North American natural gas transmission system

### *Regional Results*

The potential impacts vary by state, with those most dependent on gas for peak electric power generation benefiting the most. In addition to the bill savings from reduced natural gas prices and consumption that retail customers would realize from energy efficiency measures, the customer would also experience additional savings from reductions in electricity prices and consumption. The model used for our analysis does not project electricity prices, so we cannot quantify these savings. However, if we assume that consumer electricity prices would remain constant at 2002 levels (they are actually forecast to rise), the dollar savings nationally would be similar to those from natural gas savings. We would, however, anticipate significant variation in the ratio of electric-to-gas savings among the states due to variation in the end-use energy mix. Several examples follow.

*Midwest*

Natural gas represents an increasingly important energy source for the Midwest. Average residential gas customer natural gas bills are 3.6 times as much as the national average, with

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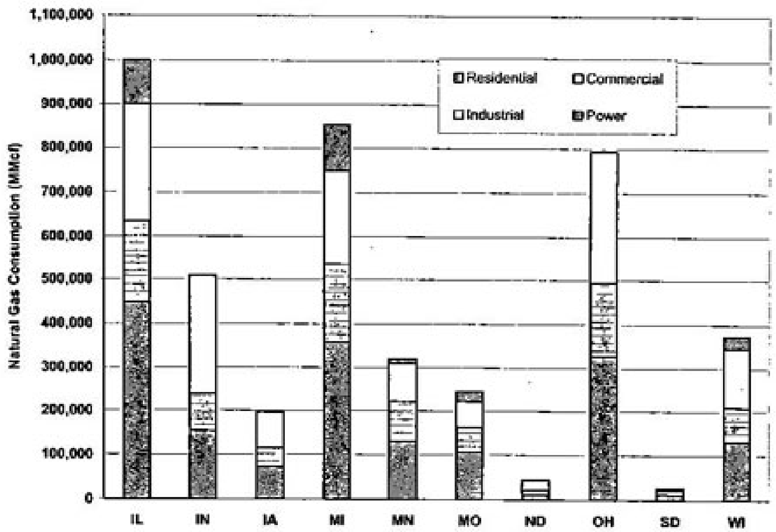
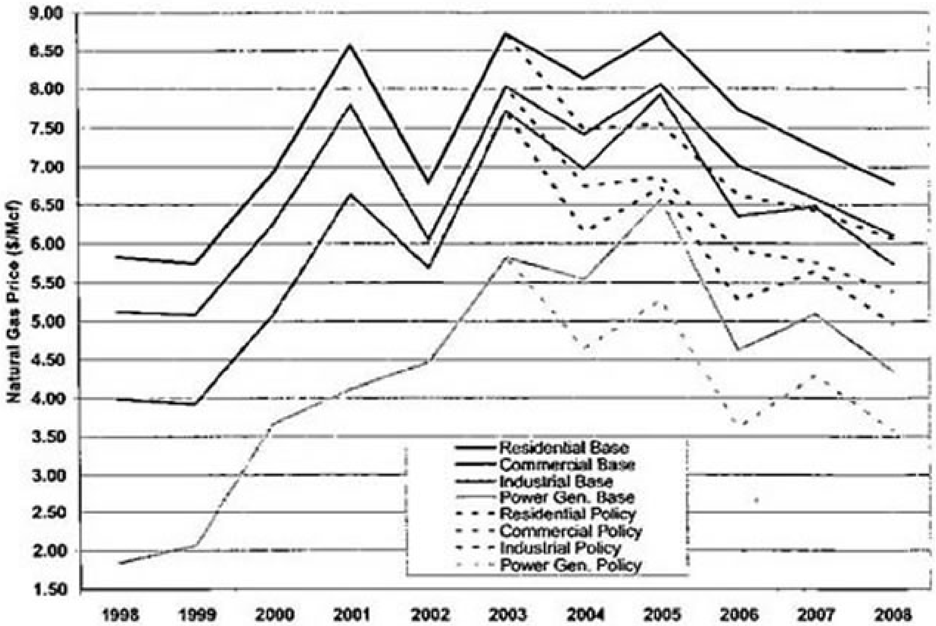
residential customers' bills in Illinois being 4.5 times the national average. Natural gas consumption in the residential, commercial and industrial sectors of the Midwest is projected to continue to grown at a rate slightly greater than the national average over the next five years. Electric power generation from gas in the region is relatively modest, with only Michigan having significant share of total generation from natural gas generation at 12% (EIA/EA 2003). However, projections suggest that natural gas generation in Indiana, North Dakota and Ohio will grow rapidly in coming years.

**Figure 12. 2002 Natural Gas Consumption in the Midwest (Source: EEA 2003).**




Wholesale natural gas prices in the Midwest average slightly less than the national average, except for the industrial sector where prices are slightly above national averages. There is significant variation in the industrial, commercial, residential, and power generation prices in the various states. Natural gas prices in the region are projected to remain high in the base case (Figure 13). With expanded energy efficiency and renewable energy at the national level, natural gas prices are projected to be reduced dramatically, with industrial and power sectors seeing the greatest price reductions.

**Figure 13. Historical and Projected Retail Natural Gas Prices**




EE and RE policies reduce natural gas consumption in the residential and commercial sectors in all the states in the region (see Figure 14). Industrial consumption of gas expands robustly in Illinois, Indiana, Michigan and Ohio reflecting an enhanced recovery of these depressed energy intensive industries due to reduced natural gas prices. Natural gas consumption by electric power generators in Indiana, Michigan and Ohio expands due to the reduced price of natural gas to the power sector. Part of this increase is likely due to expanded operation of industrial CHP facilities in these states reflecting the corresponding increase in industrial activity.

Total expenditures for natural gas decline in almost all sectors in all states in the region, except for the power and manufacturing sectors in Indiana and Ohio where increased industrial activity outweighs the price and efficiency savings (Figure 15).

Figure 14. Cumulative Change in Consumption by Sector in the Midwest

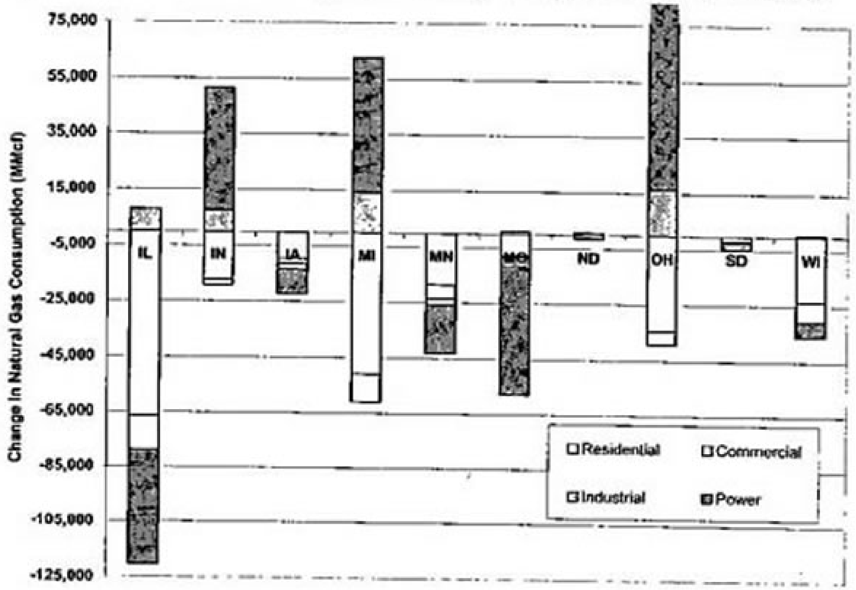
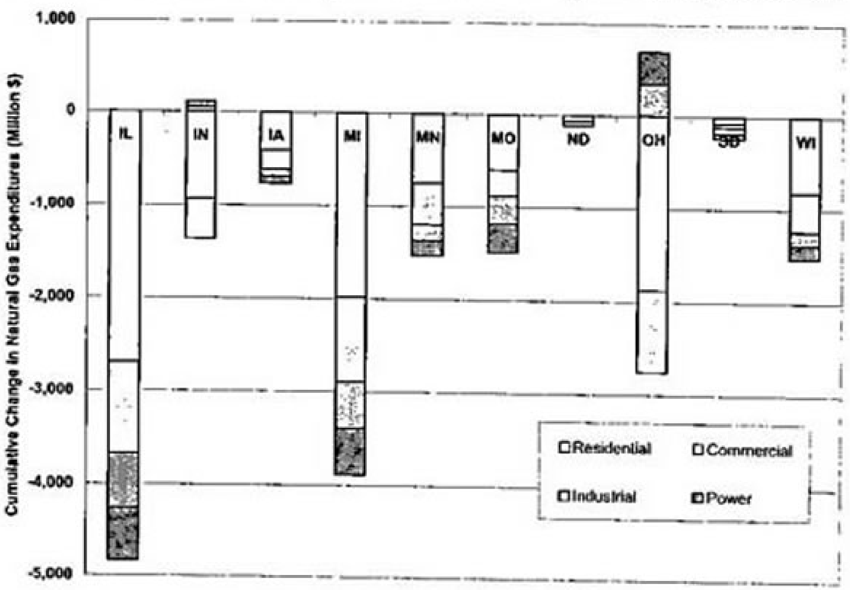



Figure 15. Cumulative Change in Natural Gas Expenditure by Sector for the Midwest



*New England and Mid-Atlantic*

How natural gas is consumed varies significantly among the New England and Mid-Atlantic states. In 2002, power generation accounted for more than 20% of total gas consumption in seven of the 12 states, the majority of total consumption in Maine and Rhode Island (Figure 16). Gas demand for power generation has increased rapidly in the region, jumping by more than 30% from 1998 to 2002. While growth is projected to decrease for the next few years, likely due to increased gas prices, rapid growth in gas fired generation is projected to resume in 2006 increasing to 169% of the 1998 level by 2008. Residential gas usage provides the base in most states in the region, varying between 20 and 50% of state consumption. Industrial gas demand is modest in New Hampshire, Pennsylvania and Vermont which all exceed 25% of total state demand. Delaware leads the region, with industrial demand accounting for about 50% of the state's total gas demand.

Natural gas prices vary significantly across the region (see Table 15). The average residential, commercial and industrial retail gas prices were above the national average in 2002, though the average power generation price was slightly below the national average. Residential prices for gas vary almost a factor of two, with Delaware and New Jersey having residential prices less than the national average. New Jersey at $5.93 per Mcf had some of the lowest cost residential gas in the country in 2002. D.C., while Massachusetts and New Hampshire all had natural gas prices approaching $11 per Mcf. Industrial and commercial prices showed similar variability. Commercial prices were more than a $1 per Mcf higher than the national average while industrial prices were almost $2 higher. Vermont was the only state in the region in which the average industrial natural gas cost is less than the national average while Maryland and Massachusetts have the highest industrial prices in the region. The range in natural gas prices was even more dramatic, with Maine and New Hampshire averaging less than $2 per Mcf and Pennsylvania leading the region at $8.74.

**Table 15. Average Annual Retail Natural Gas Price by Sector (EEA 2003).**

| | $ per thousand cubic feet (Mcf) | | | |
|---|---|---|---|---|
| | **Residential** | **Commercial** | **Industrial** | **Power Gen.** |
| **CT** | 10.63 | 6.34 | 6.06 | 5.42 |
| **DE** | 7.32 | 8.68 | 5.93 | 3.91 |
| **DC** | 10.84 | 10.58 | NA+ | NA+ |
| **ME** | 10.49 | 9.18 | 7.15 | 1.95 |
| **MD** | 9.90 | 8.75 | 8.38 | 7.12 |
| **MA** | 11.00 | 9.85 | 8.51 | 2.90 |
| **NH** | 10.96 | 9.59 | 7.10 | 1.90 |
| **NJ** | 5.93 | 6.22 | 5.76 | 3.26 |
| **NY** | 9.98 | 8.22 | 6.67 | 4.05 |
| **PA** | 9.78 | 9.08 | 6.31 | 8.74 |
| **RI** | 10.37 | 9.12 | 5.74 | 4.72 |
| **VT** | 8.31 | 6.41 | 4.32 | 4.25 |
| **NE/PJM Region** | 9.29 | 8.12 | 6.70 | 3.90 |
| **US Average** | 7.86 | 6.95 | 4.79 | 4.22 |

Notes: + D.C. has no significant reported Industrial or Power Generation natural gas sales so no price available.